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(54) **METHOD AND SYSTEM FOR FINISHING GLASS SHEETS**

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B24B 9/06 (2006.01)

(52) **U.S. Cl.**
CPC .. ***B24B 9/065*** (2013.01); ***B24B 9/10*** (2013.01)

(58) **Field of Classification Search**
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USPC 451/5, 44, 43, 365, 57, 58
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,356,433	A *	8/1944	Roesch et al.	451/273
4,777,768	A *	10/1988	Audi et al.	451/127
5,727,990	A *	3/1998	Hasegawa et al.	451/44
6,615,613	B1 *	9/2003	Iwabuchi et al.	65/61
6,845,635	B2	1/2005	Watanabe et al.	
8,231,433	B2 *	7/2012	Haneda et al.	451/44
8,408,970	B2	4/2013	Ueda	
2002/0037687	A1 *	3/2002	Yamahara	451/43
2003/0082999	A1 *	5/2003	Yoshikawa et al.	451/41
2007/0196699	A1 *	8/2007	Aida	428/846.1
2009/0038743	A1 *	2/2009	Suzuki	G11B 5/8404 156/154
2010/0285726	A1 *	11/2010	Ueda	B24B 5/04 451/41

FOREIGN PATENT DOCUMENTS

CN	1058366	3/1993
CN	101356575	9/2011
JP	2002150546	5/2002
JP	2008302448	12/2008

OTHER PUBLICATIONS

English Translation of Notice on the First Office Action for CN Appl No. 201310225850.7, dated Feb. 1, 2016, 10 pages.

* cited by examiner

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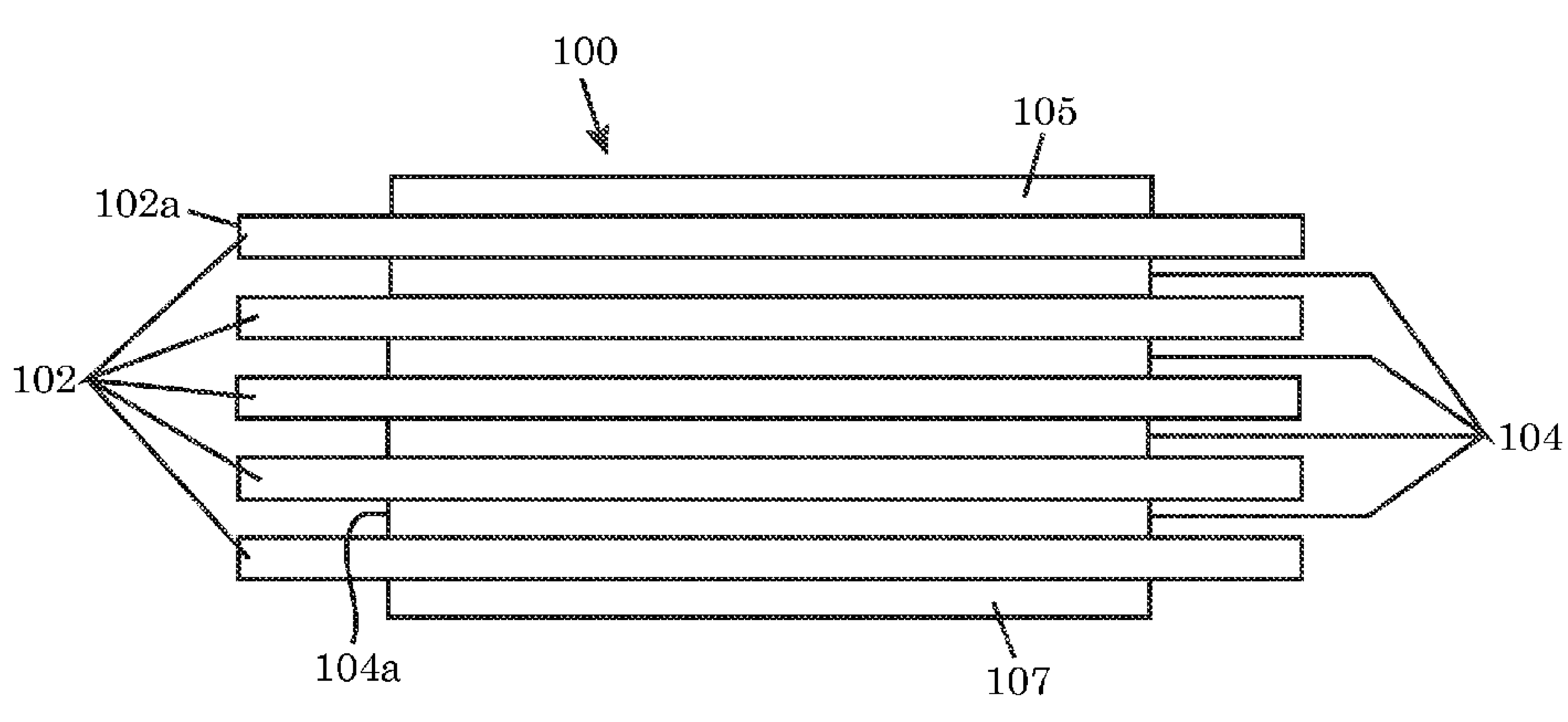
(57) **ABSTRACT**

A method of finishing glass sheets includes forming a stack comprising alternating layers of unfinished glass sheets and spacer pads. The stack is such that there is no physical contact between any two adjacent unfinished glass sheets and outer edges of the spacer pads are recessed relative to outer edges of the unfinished glass sheets. The stack is secured by clamping the unfinished glass sheets and spacer pads together and then supported on a working surface. The unfinished glass sheets of the stack are finished simultaneously while the stack is supported on the working surface. After the finishing, the stack comprises alternating layers of finished glass sheets and spacer pads.

15 Claims, 4 Drawing Sheets



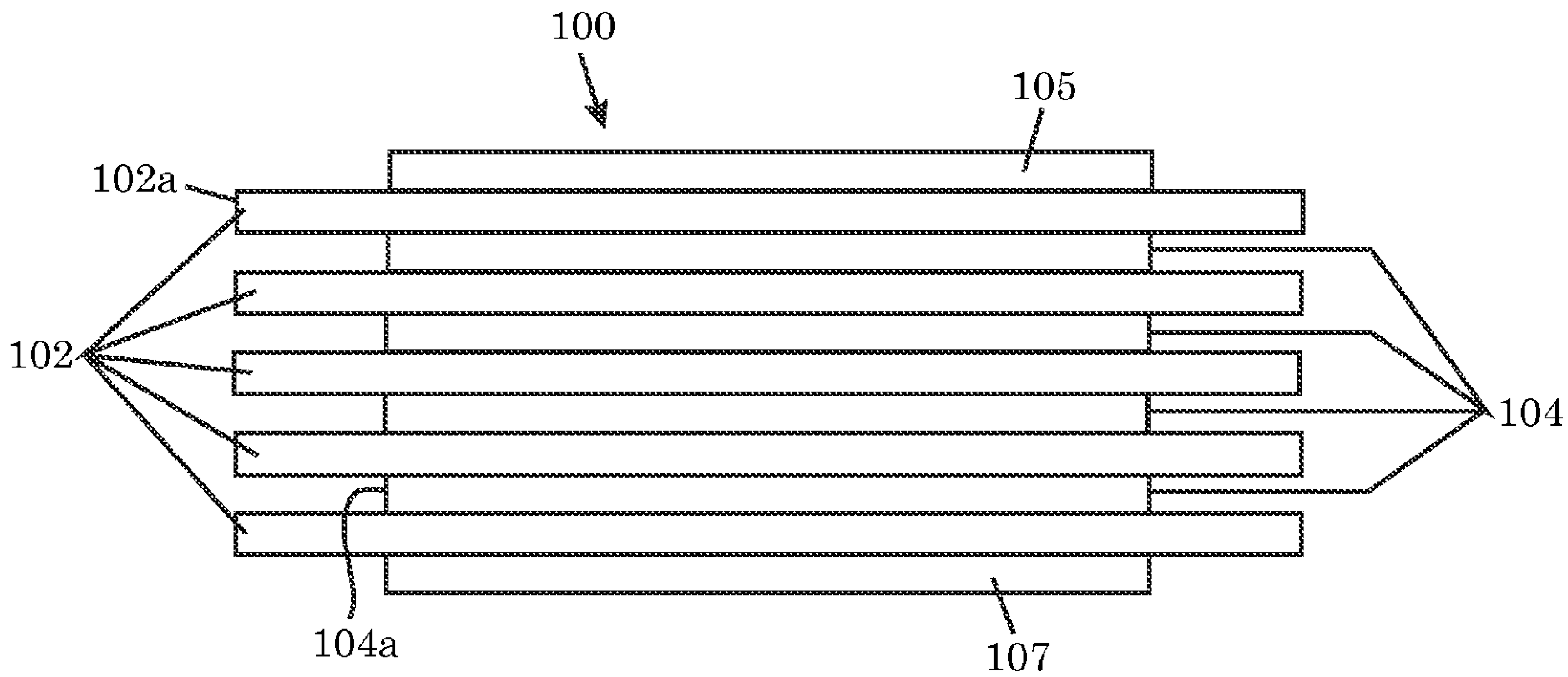


Fig. 1

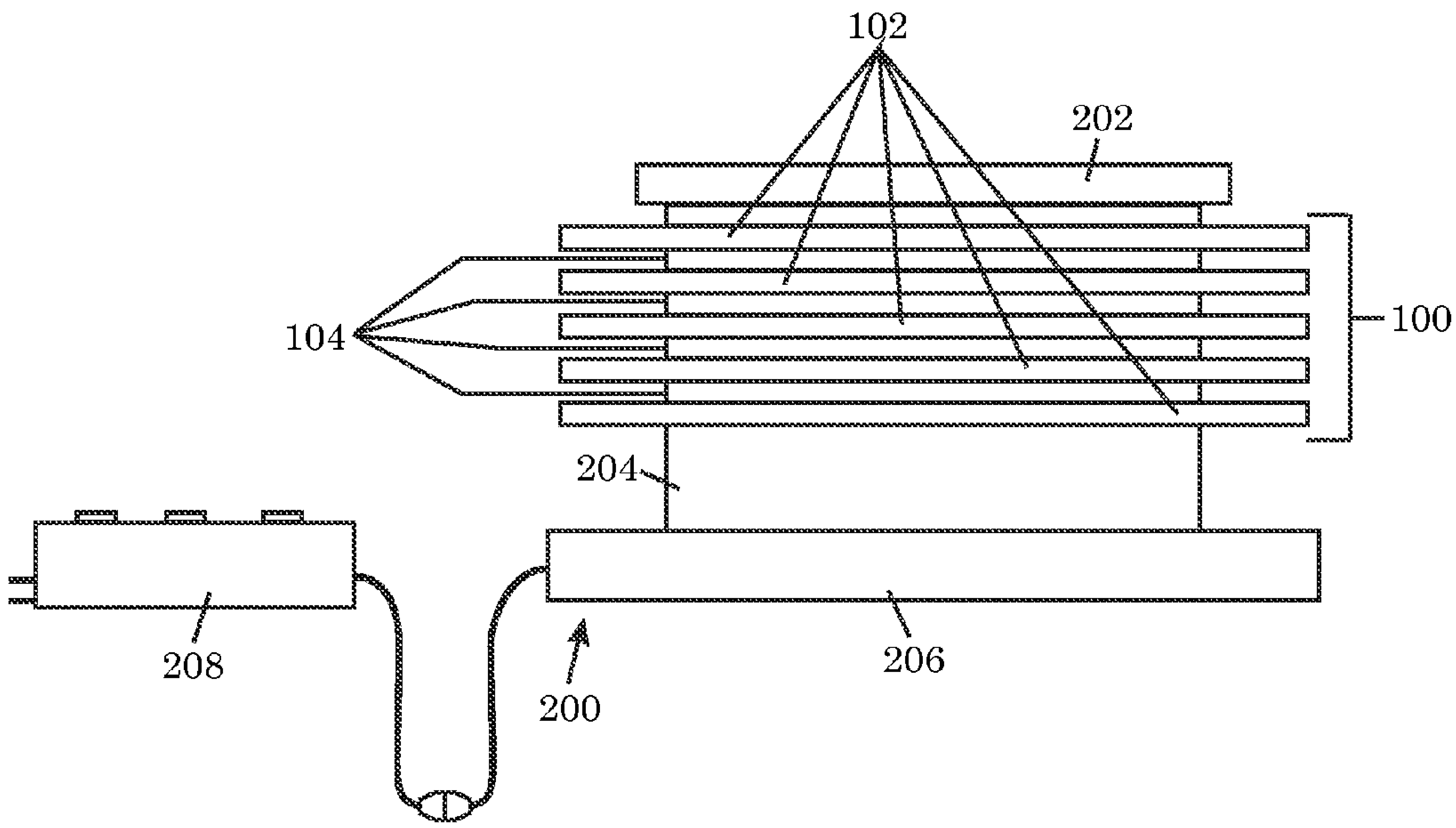


Fig. 2

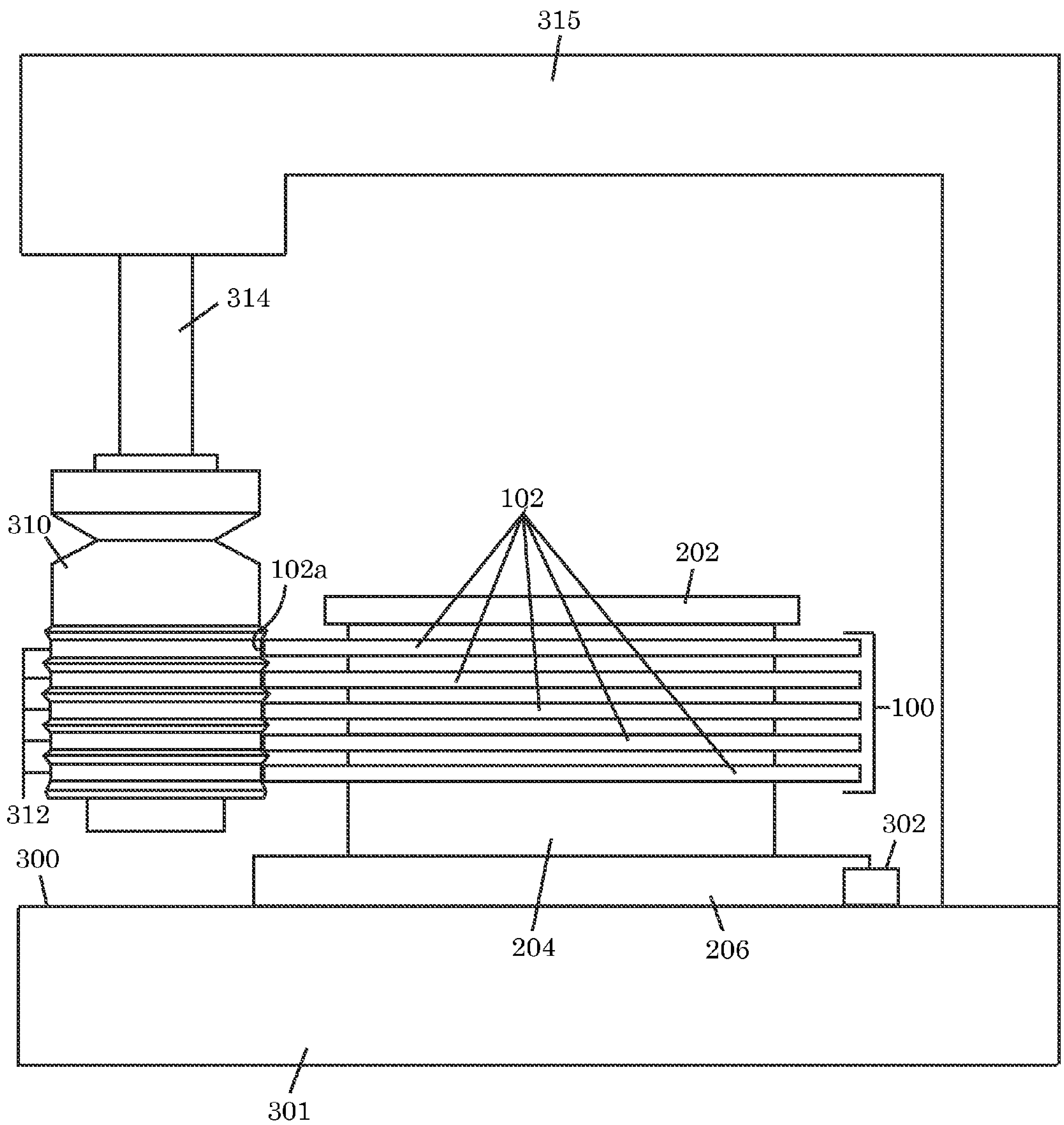


Fig. 3

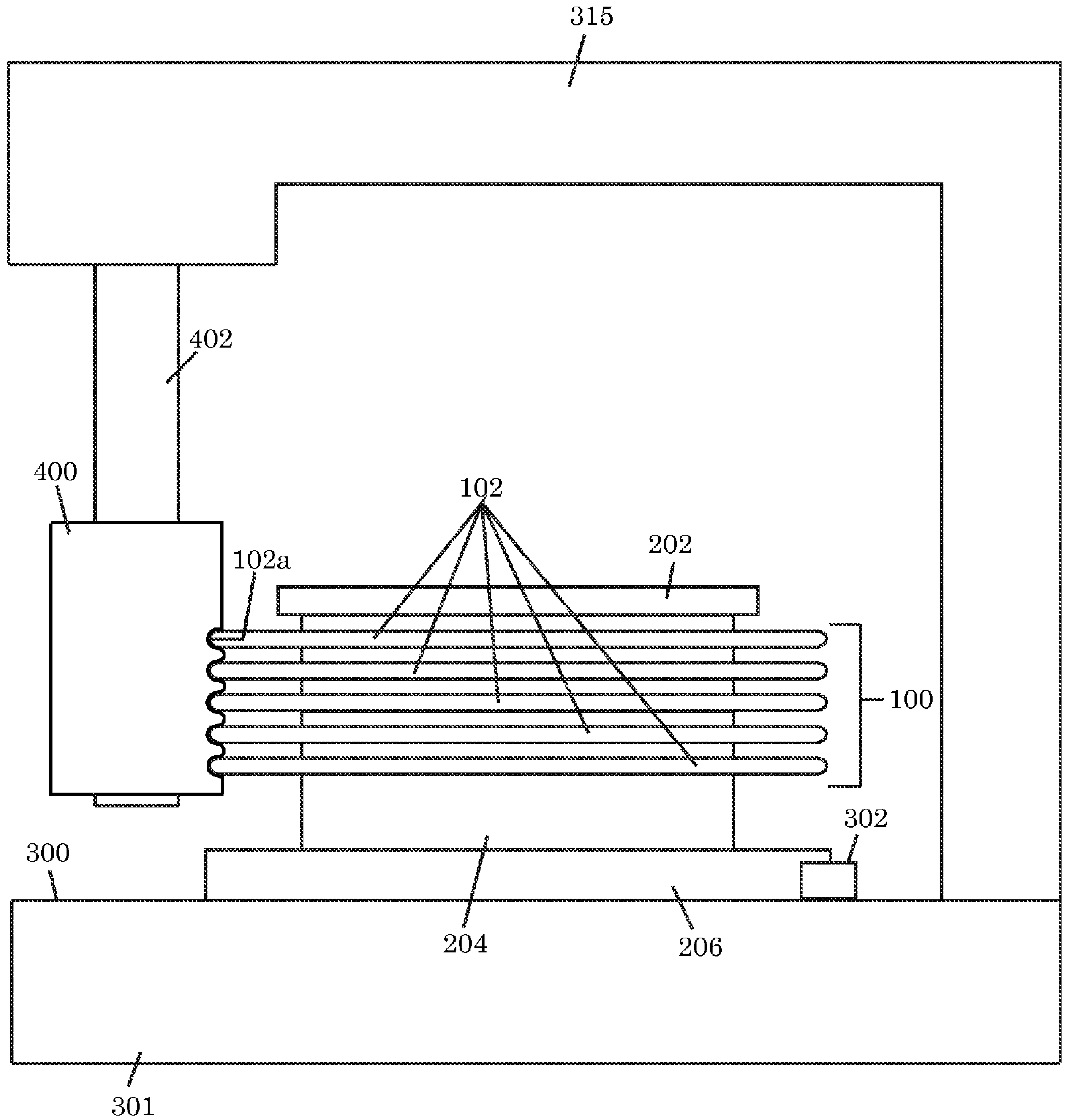


Fig. 4

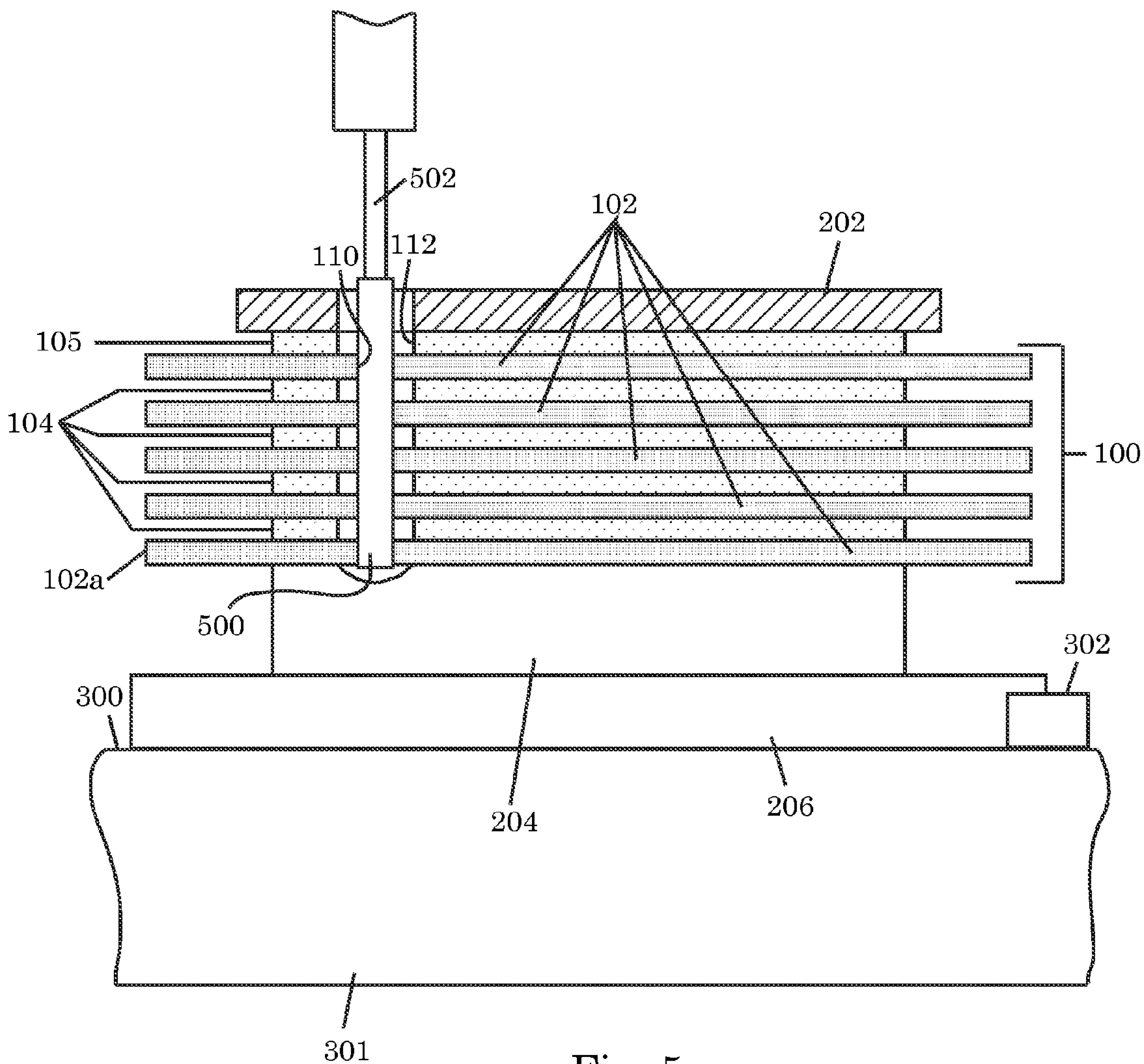


Fig. 5

METHOD AND SYSTEM FOR FINISHING GLASS SHEETS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of priority under 35 U.S.C. §119 of U.S. Provisional Application Ser. No. 61/624,584 filed on Apr. 16, 2012, the content of which is relied upon and incorporated herein by reference in its entirety.

BACKGROUND

The invention relates to processes for finishing glass sheets.

Glass sheets may have rough edges that must be finished prior to their use in target applications. Typically, finishing is a combination of grinding and polishing to remove material from the rough edges and thereby smooth out the rough edges. In some cases, finishing may include lapping. A typical finishing scheme includes grinding the rough outer edges of the glass sheets, one glass sheet at a time, followed by polishing the rough inner edges of the glass sheets, one glass sheet at a time. After this initial outer edge grinding and inner edge polishing for each glass sheet, the glass sheets are stacked together in physical contact. Then, the outer edges of the stacked glass sheets are polished together. Finally, the glass sheets are separated. Throughput is relatively low with this finishing scheme.

SUMMARY

In one aspect of the present invention, a method of finishing glass sheets includes forming a stack having alternating layers of unfinished glass sheets and spacer pads. The stack is such that there is no physical contact between any two adjacent unfinished glass sheets. The stack is also such that outer edges of the spacer pads are recessed relative to outer edges of the unfinished glass sheets. The method includes securing the stack by clamping the unfinished glass sheets and spacer pads together. The secured stack is supported on a working surface. The method includes finishing the unfinished glass sheets of the stack simultaneously while the stack is supported on the working surface. After the finishing, the stack has alternating layers of finished glass sheets and spacer pads.

In one embodiment, the finishing of the glass sheets includes removing material from rough edges of the unfinished glass sheets.

In one embodiment, the finishing of the glass sheets includes grinding the outer edges of the unfinished glass sheets simultaneously.

In one embodiment, the grinding of the outer edges includes a plurality of grinding passes, where each grinding pass involves use of an abrasive material with a predetermined grit size.

In one embodiment, the predetermined grit size decreases with each successive grinding pass.

In one embodiment, the grinding of the outer edges includes shaping the outer edges of the unfinished glass sheets.

In one embodiment, the finishing of the glass sheets further includes polishing the outer edges of the unfinished glass sheets simultaneously.

In one embodiment, the polishing of the glass sheets includes a plurality of polishing passes.

In one embodiment, the method further includes forming holes in the unfinished glass sheets before or during the finishing, where the holes are bounded by inner edges.

In one embodiment, the finishing of the glass sheets includes polishing the inner edges simultaneously.

In one embodiment, the method further includes forming slots in the outer edges of the unfinished glass sheets before or during the finishing.

In one embodiment, the securing of the stack includes placing the stack in a magnetizer fixture that applies a magnetic clamping force to the stack.

In one embodiment, the supporting of the stack includes aligning the stack to a working position on the working surface and clamping the stack to the working surface at the working position.

In one embodiment, the finishing of the glass sheets occurs without altering the layer arrangement of the stack throughout the finishing.

In one embodiment, the finishing of the glass sheets includes use of a plurality of finishing tools operated by a computer numerical control machine.

In one embodiment, the finishing of the glass sheets includes separating the finished glass sheets from the spacer pads.

In one embodiment, the method further includes removing the stack from the working surface and immersing the stack in a liquid medium prior to the separating of the finished glass sheets from the spacer pads.

In another aspect of the present invention, a system of finishing glass sheets includes a plurality of finishing tools, where each finishing tool is configured to perform at least one of grinding and polishing. The system includes a computer numerical control machine capable of operating the plurality of finishing tools. The system includes a replaceable stack mounted on a working surface of the machine in a position to be acted on by a finishing tool operated by the machine. The replaceable stack includes alternating layers of unfinished glass sheets and spacer pads. The replaceable stack is such that there is no physical contact between any two adjacent unfinished glass sheets. The replaceable stack is also such that outer edges of the spacer pads are recessed relative to outer edges of the unfinished glass sheets. The system includes means for clamping the unfinished glass sheets and the spacer pads together.

In one embodiment, the system further includes means for clamping the replaceable stack to the working surface.

In one embodiment, the means for clamping the unfinished glass sheets and spacer pads together includes a magnetizer fixture capable of applying a magnetic clamping force to the replaceable stack.

In one embodiment, the spacer pads are made of a conformable material.

The foregoing summary and the following detailed description are exemplary of the invention and are intended to provide an overview or framework for understanding the nature and character of the invention as it is claimed. The accompanying drawings are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification. The drawings illustrate various embodiments of the invention and together with the description serve to explain the principles and operation of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The following is a description of the figures in the accompanying drawings. The figures are not necessarily to scale, and certain features and certain views of the figures may be shown exaggerated in scale or in schematic in the interest of clarity and conciseness.

FIG. **1** is a schematic of a stack of glass sheets interleaved with spacer pads.

FIG. **2** is a schematic of a stack of glass sheets and spacer pads clamped in a magnetizer fixture.

FIG. **3** is a schematic of simultaneous grinding of the outer rough edges of glass sheets in a stack.

FIG. **4** is a schematic of simultaneous polishing of the outer rough edges of glass sheets in a stack.

FIG. **5** is a schematic of simultaneous polishing of the inner rough edges of glass sheets in a stack.

DETAILED DESCRIPTION

In the following detailed description, numerous specific details may be set forth in order to provide a thorough understanding of embodiments of the invention. However, it will be clear to one skilled in the art when embodiments of the invention may be practiced without some or all of these specific details. In other instances, well-known features or processes may not be described in detail so as not to unnecessarily obscure the invention. In addition, like or identical reference numerals may be used to identify common or similar elements.

A method of finishing glass sheets according to one embodiment of the invention involves providing a plurality of unfinished glass sheets. Here, the term "unfinished glass sheet" refers to a glass sheet having one or more rough edges that need to be finished. A rough edge may include micron-scale breaks and chips. An edge may be considered rough if it has a surface roughness greater than 350 nm, as measured by a ZYGO® Newview 3D optical surface profiler. Each unfinished glass sheet is bounded by an outer (circumferential) edge, which may be rough and require finishing. The outer edge may be considered to be rough even if only a portion of the outer edge is rough. In this case, the required finishing may be only where the outer edge is rough. Each unfinished glass sheet may have one or more holes, each of which is bounded by an inner (circumferential) edge, where the inner edge may be rough and require finishing. The inner edges and outer edges may define a variety of shapes, e.g., rectangle, square, circle, and oval, depending on the target applications of the finished glass sheets. The unfinished glass sheets are typically flat.

The unfinished glass sheets may be strengthened glass sheets, i.e., glass sheets that have been subjected to a chemical strengthening process, such as an ion-exchange process, or a thermal strengthening process, such as annealing. The base compositions of the glass sheets are selected based on the target applications of the glass sheets and may be further selected based on the strengthening processes that would be applied to the glass sheets. For example, where strong glass sheets are desired and an ion-exchange process is to be used for strengthening of the glass sheets, the base compositions of the glass sheets would need to be ion-exchangeable. Ion-exchangeable glasses are characterized by the presence of small alkali metal or alkaline-earth metal ions that can be exchanged for larger alkali or alkaline-earth metal ions. Typically, ion-exchangeable glasses are alkali-aluminosilicate glasses or alkali-aluminoborosilicate glasses. Specific examples of ion-exchangeable glasses are disclosed in U.S. Pat. No. 7,666,511 (Ellison et al; 20 Nov. 2008), U.S. Pat. No. 4,483,700 (Forker, Jr. et al.; 20 Nov. 1984), and U.S. Pat. No. 5,674,790 (Araujo; 7 Oct. 1997); U.S. patent application Ser. No. 12/277,573 (Dejneka et al.; 25 Nov. 2008), Ser. No. 12/392,577 (Gomez et al.; 25 Feb. 2009), Ser. No. 12/856,840 (Dejneka et al.; 10 Aug. 2010), Ser. No. 12/858,490 (Barefoot et al.; 18 Aug. 18, 2010), and Ser. No. 13/305,271 (Bookbinder et al.; 28 Nov. 2010); and U.S. Provisional Patent Application No. 61/503,734 (Dejneka et al.; 1 Jul. 2011).

The method includes forming a stack including several unfinished glass sheets interleaved with spacer pads. The spacer pads may be made of conformable material so that the shape of the spacer pads conforms to that of the adjacent unfinished glass sheets. The stack has at least two unfinished glass sheets. Preferably, the stack has more than two unfinished glass sheets. In some embodiments, the stack has at least five unfinished glass sheets. The unfinished glass sheets and spacer pads are arranged in alternating layers so that there is no physical contact between any two adjacent unfinished glass sheets.

For illustration purposes, FIG. **1** shows a stack **100** including unfinished glass sheets **102** interleaved with spacer pads **104**. The height of the spacer pads **104** may depend on a particular finishing tool that will be applied to the glass sheets **102**, as will be further discussed below. An end pad **105** may be placed on top of the stack **100** to protect the topmost unfinished glass sheet **102**. Similarly, an end pad **107** may be placed below the bottom of the stack **100** to protect the bottommost unfinished glass sheet **102**. The spacer pads **104** are preferably made of materials that would not scratch or mar the surface of the unfinished glass sheets **102**. For example, the spacer pads **104** could be made of a polymeric material, such as butyl rubber, silicone, polyurethane, or natural rubber. The spacer pads **104** are selected to be smaller in size than the unfinished glass sheets **102** and stacked in such a way that their outer (circumferential) edges **104*a*** are recessed in the stack **100** relative to the outer edges **102*a*** of the unfinished glass sheets **102**. This would allow free access to the outer edges **102*a*** of the unfinished glass sheets **102** for the purpose of finishing the outer edges **102*a***. The end pads **105**, **107** may have the same characteristics as the spacer pads **104**.

The method includes securing the stack **100** by clamping the unfinished glass sheets **102** and the spacer pads **104** together so that there is no relative motion between the unfinished glass sheets **102** and the spacer pads **104**. Any suitable method may be used to secure the stack **100**. Preferably, the method of securing the stack **100** will not interfere with finishing of the outer edges **102*a*** of the unfinished glass sheets **102**.

In one embodiment, as shown in FIG. **2**, a magnetizer fixture **200** is used to clamp the glass sheets **102** and the spacer pads **104** of the stack **100** together. The magnetizer fixture **200** includes a cover part **202** made of one or more magnets and a base part **204** made of one or more magnets. In one embodiment, each of the cover part **202** and base part **204** is made of an electromagnet. The parts **202**, **204** may be in the form of plates. The cover part **202** is positioned over the base part **204** and spaced apart from the base part **204** to create a gap sufficient to accommodate the height of the stack **100**. The base part **204** is mounted on a magnetizer **206**. There should be some physical contact between the base part **204** and the magnetizer **206**. However, whole surface contact between the base part **204** and magnetizer **206** is not necessary. When the magnetizer **206** receives current and is energized, it applies a magnetic field in the vicinity of the parts **202**, **204** to draw the cover part **202** to the base part **204**, thereby clamping the stack **100** in between the plates **202**, **204**. The clamping force applied to the stack **100** is proportional to the current delivered to the magnetizer **206**. This current can be adjusted by or through the magnetizer controller **208**. The magnetizer **206** may be obtained from commercial vendors and may be further customized to provide sufficient magnetic power to clamp the stack **100** in between the parts **202**, **204**.

Other methods of clamping the unfinished glass sheets **102** and the spacer pads **104** together besides magnetic means may be used. For example, the stack **100** may be sandwiched between plates and a weight may be applied to one of the plates to clamp the stack **100** in between the plates.

The method includes placing the stack **100** in its secured (clamped) state on a working surface, such as a working surface of a computer numerical control ("CNC") machine. FIG. **3** shows the stack **100** on a working surface **300** of a CNC machine **315**. The stack **100** is aligned to a working position on the working surface **300**, e.g., using one or more alignment blocks **302**, and then secured in that position. Vacuum clamping or other means of maintaining the working position of the stack **100** on the working surface **300** may be used. The base **301**, which provides the working surface **300**, may incorporate the clamping means, such as port(s) through which vacuum can be applied to the secured stack **100**. The CNC machine **315** may be obtained from commercial vendors. One example of a suitable CNC machine is CL-3MGC CNC machine, available from Chuan Liang Industrial Co., Ltd. Any commercial CNC machine used may be further customized as needed to hold and operate a selection of finishing tools, such as grinding and polishing tools.

After the stack **100** is secured in the working position, finishing tools are applied to the unfinished glass sheets **102** to finish the unfinished glass sheets **102** simultaneously, i.e., each application of the finishing tool involves interaction between the finishing tool and all the glass sheets in the stack at the same time. Finishing of the unfinished glass sheets **102** can take on various forms. Typically, finishing will include grinding the outer edges **102***a* of the unfinished glass sheets **102** simultaneously, followed by polishing the outer edges **102***a* of the unfinished glass sheets **102** simultaneously. If the unfinished glass sheets **102** have holes in them and these holes are aligned in the stack **100**, finishing may include polishing the inner edges defining the aligned holes simultaneously. Additional processes may be carried out before or during the finishing. For example, slots may be punched in the outer edges **102***a* of the glass sheets **102** and then finished along with the outer edges **102***a*. In another example, holes may be punched through the unfinished glass sheets **102** in the stack **100** and then polished simultaneously.

In one embodiment, as shown in FIG. **3**, the outer edges **102***a* of the unfinished glass sheets **102** are finished simultaneously using a grinding tool **310**. The grinding tool **310** has a plurality of circumferential, axially spaced-apart notches **312**. The surfaces defining the notches **312** incorporate abrasive material for grinding. Alternatively, the grinding tool **310** may be made wholly of an abrasive material. The material may be selected from, for example, alumina, silicon carbide, diamond, cubic nitride, and pumice. The spacing between the notches **312** corresponds to the spacing between the unfinished glass sheets **102** so that there is a one-to-one correspondence between the notches **312** and the outer edges **102***a* of the unfinished glass sheets **102**. The profiles of the notches **312** are selected based on the desired profiles of the outer edges **102***a* after grinding. For example, the notches **312** may have a flat, round, or beveled profile to make the outer edges **102***a* flat, round, or beveled, respectively. The notches **312** may have identical or different profiles.

The grinding tool **310** is mounted on a spindle **314** to rotate with the spindle **314** or about the spindle **314**. For finishing, the grinding tool **310** is rotated while being translated along the outer edges **102***a*. The CNC machine **315** controls rotation and translation of the grinding tool **310**. As the grinding tool **310** is rotated and translated, each of the notches **312** engages a corresponding one of the outer edges **102***a*. In the engaged position, the abrasive material in the notches **312** and the relative motion between the notches **312** and outer edges **102***a* result in removal of material from the outer edges **102***a*. How much material is removed will depend on the grit size of the abrasive material and the grinding force due to contact between the grinding tool **310** and the outer edges **102***a*. The grinding may occur in several passes, with each successive pass possibly using a different grit size. Grit size may be changed by replacing the grinding tool **310** with another grinding tool having the appropriate grit size. In general, the higher the grit size, the less aggressive is the removal of material from the outer edges **102***a*. Typically, the grit size will increase with each successive pass. For example, a 350 mesh grit size (corresponding to diamond grain size of about 40 μm) may be used for the beginning pass (or passes), and 600 mesh grit size (corresponding to diamond grain size of about 24 μm) may be used for the final pass (or passes). For each pass, the grinding tool **310** may traverse the entire length of each outer edge **102***a* or just a portion of the entire length of each outer edge **102***a*, depending on how much of each outer edge **102***a* requires finishing.

In one embodiment, as shown in FIG. **4**, after grinding, the outer edges **102***a* are polished simultaneously using a polishing tool **400** operated by the CNC machine **315**. The polishing tool **400** may be, for example, in the form of a wheel or pad or brush. Preferably, the polishing tool **400** is made of a conformable material so that it can conform to the shape of the outer edges **102***a*. The polishing tool **400** may be made of a polymeric material, such as butyl rubber, silicone, polyurethane, and natural rubber. Abrasive material is not incorporated into the polishing tool **400** as in the case of the grinding tool **310** (in FIG. **3**). However, polishing can involve use of abrasive particles. In one example, 8000 mesh abrasive particles may be used. The abrasive particles may be provided in dry or slurry form. An amount of the abrasive particles is applied onto a surface of the polishing tool **400**, and the polishing tool **400** rubs or brushes the abrasive particles against the outer edges **102***a* during the polishing. Polishing with the polishing tool **400** may occur in several passes as in the case of grinding. The polishing tool **400** is translated along the outer edges **102***a* for the polishing. The polishing tool **400** may be mounted on a spindle **402**, which may allow rotation of the polishing tool **400** while the polishing tool **400** is being translated along the outer edges **102***a*.

Other methods of polishing may be used. For example, magnetorheological finishing ("MRF") as taught in U.S. Patent Application Publication No. 2011/0318994 ("Darcangelo et al.") may be used for the polishing. In MRF, micron-sized to nano-sized magnetizable particles are suspended in a liquid vehicle to form a magnetorheological polishing fluid (MPF). The MPF is deposited on a support surface and a magnetic field is applied to the MPF. The magnetized MPF becomes stiffened and usable as a polishing tool. The stiffened MPF can be brought into contact with the outer edges **102***a* of the unfinished glass sheets **102** to polish the outer edges **102***a*.

In one embodiment, as shown in FIG. **5**, each of the unfinished glass sheets **102***a* has a hole **110**, and the holes **110** are aligned when the unfinished glass sheets **102***a* are in the stack **100**. The spacer and end pads **104**, **105** also have holes **112** that are aligned with the holes **110**. The spacer pad holes **112** are bigger than the glass sheet holes **110** so that the spacer pad holes **112** are recessed relative to the glass sheet holes **110** from the viewpoint of the glass sheet holes **110**. With this configuration, the spacer and end pads **104**, **105** will not interfere with polishing of the glass sheet holes **110**.

A polishing tool **500** is inserted into the aligned glass sheet holes **110** to polish the inner edges of the glass sheets **102** defining (or bounding) the holes **110**. In one embodiment, the polishing tool **500** has the same characteristics as the polishing tool **400** (in FIG. **4**) described above, except that the polishing tool **500** is shaped for insertion into the aligned glass sheet holes **110**. The polishing tool **500** may be mounted on a spindle or handle **502**, which can allow rotation or translation of the polishing tool **500** within the aligned glass sheet holes **110**. Rotation and/or translation of the polishing tool **500** can be controlled by the CNC machine (**315** in FIGS. **3** and **4**). It is also possible to use other methods of polishing the glass sheet holes **110**. For example, a stiffened MPF in tubular form may be inserted into the aligned glass sheet holes **110** and used to polish the aligned glass sheet holes **110**.

The holes **110** may be pre-punched in the unfinished glass sheets **102** before forming the stack **100**. Alternatively, the holes **110** may be punched in the unfinished glass sheets **102** after forming the stack **100** using a suitable hole punching tool. This punching may occur at any time during the finishing of the outer edges **102***a* or before the finishing of the outer edges **102***a*. After punching, the holes **110** can be finished as described above.

The entire finishing can occur without having to alter the layer arrangement of the stack **100** at any point during the finishing. The entire finishing can also occur without having to remove the stack **100** from the working surface **300** at any point during the finishing. Being able to load the stack **100** onto a CNC machine once and finish the stack **100** without having to unload and change the configuration of the stack **100** at any point during the finishing saves time and leads to a higher throughput.

The glass sheets **102** in the stack **100** that have been finished as described above have smooth inner and outer edges. In one embodiment, the roughness of the outer and inner edges of the glass sheets **102** after finishing as described above is less than 100 nm, as measured by a ZYGO® Newview 3D optical surface profiler.

After the glass sheets **102** in the stack **100** have been finished as described above, the means for clamping the glass sheets **102** to the spacer pads **104** is removed. Then, the finished glass sheets **102** are separated from the spacer pads **104**. Since there is no direct contact between adjacent glass sheets **102**, unstacking of the finished glass sheets **102** involves mainly lifting layers of the stack **100** (i.e., lifting a glass sheet, then a spacer pad, one at a time). If desired, the stack **100** may be immersed in a fluid medium prior to being unstacked and then unstacked while in the fluid medium.

After the finished glass sheets have been removed from the stack, the finished glass sheets can be subjected to additional processes, such as a strengthening process. In one embodiment, the finished glass sheets are subjected to an ion-exchange process. For the ion-exchange process to work, the glass sheets would have to be made of ion-exchangeable glass, as already described above. Pre-finishing strengthening of the glass sheets may not be needed if the finished glass sheets will be subjected to a post-finishing strengthening process. In some cases, the finishing of the glass sheets may be sufficient such that strengthening of the glass before or after finishing is not needed.

While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

The invention claimed is:

1. A method of finishing glass sheets, comprising:

forming a stack comprising alternating layers of unfinished glass sheets and spacer pads, the stack being such that there is no physical contact between any two adjacent unfinished glass sheets and outer edges of the spacer pads are recessed relative to outer edges of the unfinished glass sheets;

securing the stack by clamping the unfinished glass sheets and spacer pads together in a magnetizer fixture that applies a magnetic clamping force to the stack;

placing the stack, in its secured state, on a working surface;

supporting the stack that has been secured on a working surface;

finishing the unfinished glass sheets of the stack simultaneously while the stack is supported on the working surface, wherein after the finishing the stack comprises alternating layers of finished glass sheets and spacer pads;

forming holes in the unfinished glass sheets before or during the finishing, the holes being bounded by inner edges; and

removing the stack, in its secured state, from the working surface, wherein

the finishing comprises grinding the outer edges of the unfinished glass sheets simultaneously,

the finishing comprises polishing the inner edges simultaneously, and

the entire finishing occurs without unsecuring the stack or removing the stack from the working surface.

2. The method of claim **1**, wherein the finishing comprises removing material from rough edges of the unfinished glass sheets.

3. The method of claim **1**, wherein the grinding comprises a plurality of grinding passes, each grinding pass involving use of an abrasive material with a predetermined grit size.

4. The method of claim **3**, wherein the predetermined grit size decreases with each successive grinding pass.

5. The method of claim **1**, wherein the grinding comprises shaping the outer edges of the unfinished glass sheets.

6. The method of claim **1**, wherein the finishing further comprises polishing the outer edges of the unfinished glass sheets simultaneously.

7. The method of claim **6**, wherein the polishing comprises a plurality of polishing passes.

8. The method of claim **1**, further comprising forming slots in the outer edges of the unfinished glass sheets before or during the finishing.

9. The method of claim **1**, wherein the supporting comprises aligning the stack to a working position on the working surface and clamping the stack to the working surface at the working position.

10. The method of claim **1**, wherein the finishing occurs without altering the layer arrangement of the stack throughout the finishing.

11. The method of claim **1**, wherein the finishing comprises use of a plurality of finishing tools operated by a computer numerical control machine.

12. The method of claim **1**, further comprising separating the finished glass sheets from the spacer pads.

13. The method of claim **12**, further comprising removing the stack from the working surface and immersing the stack in a liquid medium prior to the separating.

14. A system of finishing glass sheets, comprising:

a plurality of finishing tools, each finishing tool configured to perform at least one of grinding and polishing;

a computer numerical control machine capable of operating the plurality of finishing tools;

a replaceable stack mounted on a working surface of the machine in a position to be acted on by a finishing tool operated by the machine, the replaceable stack comprising alternating layers of unfinished glass sheets and spacer pads, the replaceable stack being such that there is no physical contact between adjacent unfinished glass sheets and outer edges of the spacer pads are recessed relative to outer edges of the unfinished glass sheets; and

a magnetizer fixture capable of applying a magnetic clamping force to the replaceable stack that clamps the unfinished glass sheets and the spacer pads together, wherein

the stack is placed onto the working surface in its secured state,

the stack is removed from the working surface in its secured state

the outer edges of the unfinished glass sheets are ground simultaneously,

the inner edges are polished simultaneously, and

the grinding and polishing are conducted without unsecuring the stack or removing the stack from the working surface.

15. The system of claim **14**, wherein the spacer pads are made of conformable material.

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